The Australian Broadband Dipole

A basic antenna, created in Australia, helps Botswana's News Service.

A paper titled "District Radio News Reporting — (A Low Cost Approach)", submitted to the East, Central and Southern African regional meeting of Broadcast Engineers by Mr. D. W. Harris, C.Eng., MIEE (A22BX), Deputy Director of Broadcasting (Enginering) at Radio Botswana, has been condensed due to space limitations, although the improvements developed by the Botswana engineers are reproduced in full, including diagrams for those that may wish to reproduce or further develop the aerial.

SUMMARY

The collection of news material for radio poses problems in many under-developed countries, where communications by road and telephone are unreliable and of poor quality over great distances.

This article describes an approach to the problem using HF transceivers in Botswana.

BACKGROUND

In common with many other developing countries, Botswana has internal communication difficulties. Roads are long and often poor in rural area. The telecommunications networks are hardly developed at all.

Therefore, a frequent criticism of Radio Botswana has been its lack of "Botswana news". It became necessary for the station to place a high priority on rapid passing of news from districts to the capital.

THE TECHNICAL PROBLEMS

An obvious solution was to use radio. VHF was useless, except for the most local Information Offices, due to distances, but HF is subject to all sorts of interference, and SSB, if used, has a limited band width unless highly sophisticated equipment is used. The choice of frequency is also critical to optimise signal-to-noise ratio and to accommodate frequency agility for remote installations would cause problems with aerials and tuning units. Also, there was the small obstacle of powering transceiver equipment.

Radio Botswana decided to investigate the use of HF SSB transceivers and overcome the problems involved. In the process, a low-cost aerial has been developed and some interesting information derived relating to non-technical staff tuning SSB signals.

THE TRANSCEIVER

A loose specification was drawn up and tenders invited from various commercial manufacturers for the supply of SSB transceivers.

The TR7 transceiver manufactured by M/s. R. L. Drake Co. offered the choice of receiver bandwidths, operation over the whole HF band, broadband output circuitry, a general-coverage receiver, 12 volt power supply and good serviceability.

One of the most difficult requirements was a "wider" transmit bandwidth. Reaction from conventional manufacturers to the request for a transmitted bandwidth greater than the standard 2.7 kHz was not good.

The TR7 has a 2.3 kHz wide filter fitted as standard but it is mechanically possible to fit any range of filters (intended for receiving only) into the "transmit" position. It was decided to try this although specifically warned against it by Drake engineers.

Tests were done with a Drake SL-6000 6 kHz broadcast filter, but they were not 100 per cent successful, so in the interests of establishing the network the transceivers were restored to their original transmit bandwidth (approximately 300 Hz-2.6 kHz) and installed. This was a startling improvement to the telephone network.

The TR7s were used for about a year and the non-technical operators quickly learned to adjust both received frequency and RF gain for best results. A modification was made to each set to allow patching a tape recorder into the transmit mode to enable passing of actual material, such as speeches, for "same day" rebroadcast, which had been virtually impossible with the telephone network previously.

When the SL-4000, a 4 kHz filter, became available, tests were again carried out. These tests proved to be successful and the resulting passband for a correctly adjusted filter/carrier combination is approximately 350-4500 Hz, a great improvement over the usual SSB bandwidth and the telephone network.

AERIALS

Due to many problems in the field with unskilled operators, seasonal changes, etc., there were difficulties to find an appropriate aerial. A broadband aerial, covering the 3-10 MHz range, was what was required, which could be simply fabricated and installed, preferably using local materials. There are very few designs which satisfy these requirements, and the TR7, in common with the new breed of solid state designs, is intolerant of a high SWR. Full output can only be obtained when the aerial is matched to within 2 : 1, although the set will still operate with a lower output if the matching is any worse than this.

A search through much technical literature eventually turned up a "Broadband Travelling Wave Dipole". This aerial was developed in the early 1970s and was claimed to have a relatively constant centre impedance of about 300 ohms over a wide bandwidth. A version was built, but it did not work but results were promising enough to merit further development.

After considerable trial and effort the version shown here was evolved. It differs from the original (AR, April, 1974 edition) by the addition of a third "tramline" down the middle. This simple addition resulted in a highly repeatable, non-critical aerial, which with the addition of a 6.25 : 1 balun showed less than 2 : 1 SWR from below 3 MHz to over 20 MHz. An important advantage of this antenna was it could be constructed very cheaply.

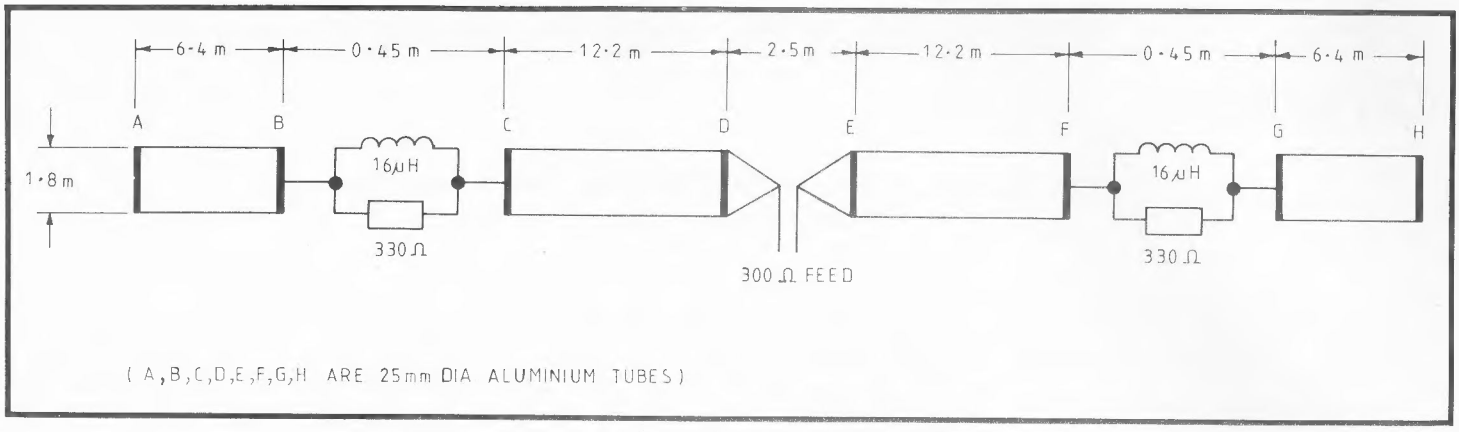
POWER SUPPLY

As there is no electricity supply at the Information Offices in the districts it was necessary to use batteries. The TR7 is essentially a 12V transceiver requiring about 1.8 amps on receive and up to 25 amps on transmit. Ordinary heavy duty car batteries were used but there were some difficulties to get them recharged, so it was decided to invest in solar panels. After a year of operation this has been entirely successful. A typical installation uses a 33 or 37 watt panel designed for 12 volt battery charging, with an anticipated battery life of around two years.

ACCURATE RESOLUTION OF SSB SIGNALS

Initially, doubts were expressed concerning the ability of the operating staff to accurately resolve incoming SSB signals. Many SSB transceivers are already in use in Botswana, by Government Departments, safari companies and the like, and a quick scan of the HF bands revealed appalling netting in many cases. It seems that, provided the recipient can make out what is being said, the "Donald Duck" sound is simply accepted as an unfortunate side-effect of SSB.

Naturally, accurate tuning was necessary if the received material was to be rebroadcast. It was a pleasant surprise to find that, after an initial training period, the news staff were able to hear mistuning and correct it using the usual RIT controls fitted to most commercial units. In this, they were helped by the digital display on the TR-7, which they seem to believe more than their own ears in some cases!



The original design

When the 4 kHz filters were introduced, the operational staff commented that it had become much easier to determine the correct tuning point with the extended bandwidth. There may be a lesson in this! No such improvement had been remarked on during the initial trials with a 6 kHz filter, but this was probably because of the intruding unwanted sideband noted earlier. It is also possible that they had not developed "communications ears" at that stage.

THE AERIAL (ORIGINAL DESIGN)

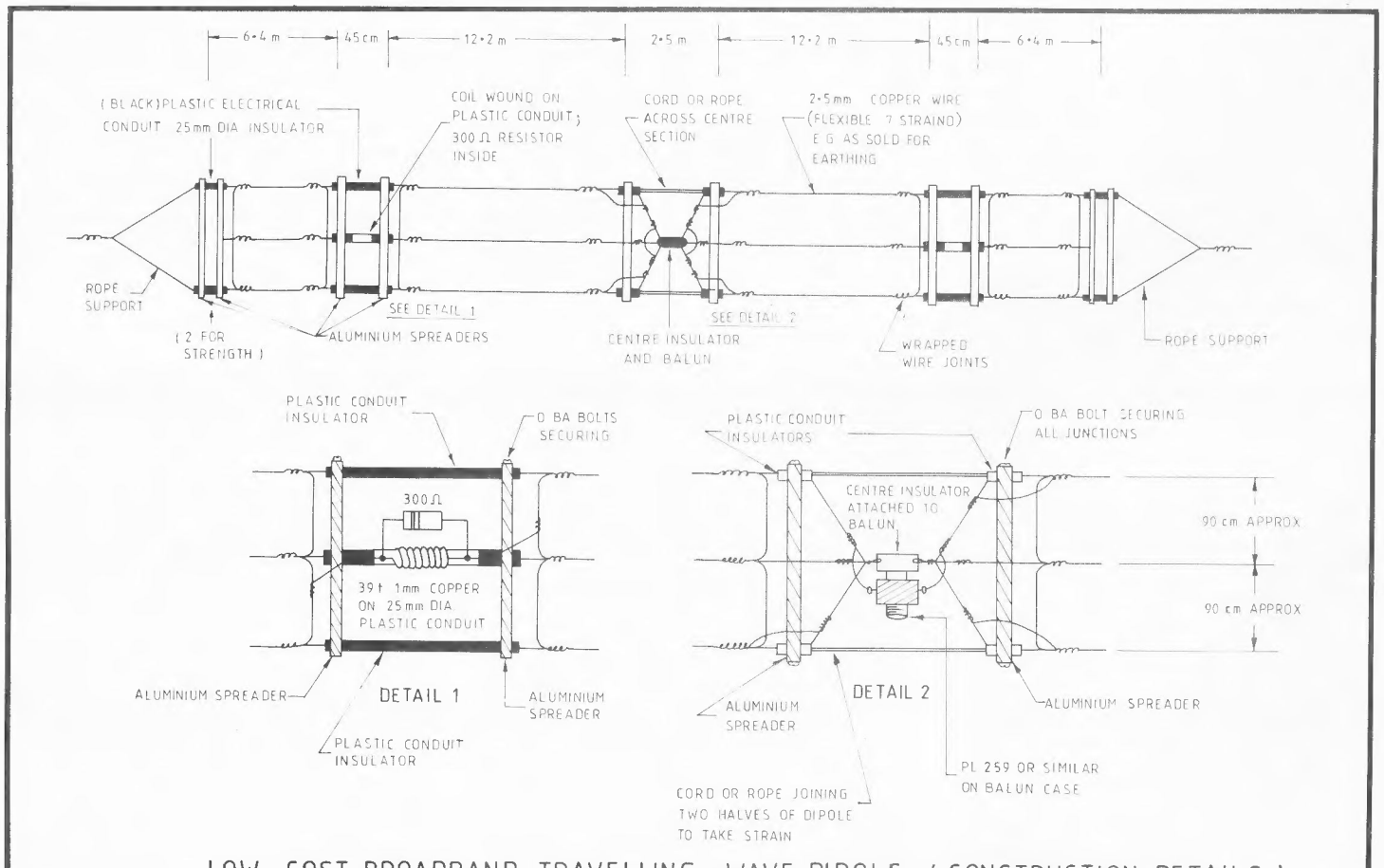
"A dipole can be modified by inserting resistive loading networks so as to produce standing waves between the feedpoint and the networks. The authors have, by adjustment of the networks and the dipole sections, developed a travelling wave dipole whose VSWR is less than 2 : 1 from 3 to 15 MHz and does not exceed 2.6 to 1 from 2.3 to at least 30 MHz."

(A, B, C, D, E, F, G, H are 25 mm diameter aluminium tubes.)

". . . neither the value of the 330 ohm resistors nor that of the shunt inductors was very critical. The shunt inductor has a small effect on SWR at the lower frequency end. However, reduction of the resistance to 150 ohms caused the SWR to fluctuate considerably with frequency. The taper sections were required to reduce shunt capacity between the spreaders D and E. Reducing the length of this section produced an increase in SWR."

Elsewhere (the ARRL Antenna Handbook), the resistors are specified as 2-5 watts rating for up to 500 watts PEP. It is also recommended that the aerial should be erected at a height of at least 40 feet (13m).

Several versions of this aerial were constructed, with varying degrees of success. The principal problem was high VSWR in the 5 to 8 MHz region. In an attempt to experiment with the shunt inductance, ferrite rod was inserted into the conduit upon which the coil was wound. It was found to be possible to adjust for low SWR at various places between 3 and



LOW-COST BROADBAND TRAVELLING-WAVE DIPOLE (CONSTRUCTION DETAILS)

9 MHz, but clearly this would be a critical procedure in the field, and in any case, the problem was solved in a different way.

MODIFIED DESIGN

An additional wire was run down the centre of the "tramlines". This dramatically reduced the fluctuations in SWR, and virtually eliminated any critical adjustments. The height of the aerial seemed to have no effect upon its matching, although of course performance was changed slightly.

Details of the construction of the aerial are given in the attached diagram. A 5 : 2 matching transformer was wound on a standard 50 mm toroid as shown.

With the exception of the toroid, all materials were obtained locally. Approximately 100m of 7-strand, 2.5 mm overall diameter copper wire was used, as sold for earthing in domestic wiring installations. It was found convenient not to use the PVC insulated type, which simplified the wire-wrapping. Cheap, black plastic 25 mm electrical conduit was used as a coil former and to make the insulators. The aluminium spreaders were very simply made, using decorative aluminium strip approximately 25 mm wide and about 10 mm thick, formed as a half "U", and sold for fronting formica table-tops and the like! Ordinary O-BA bolts were used to hold the various strips and tubes together.

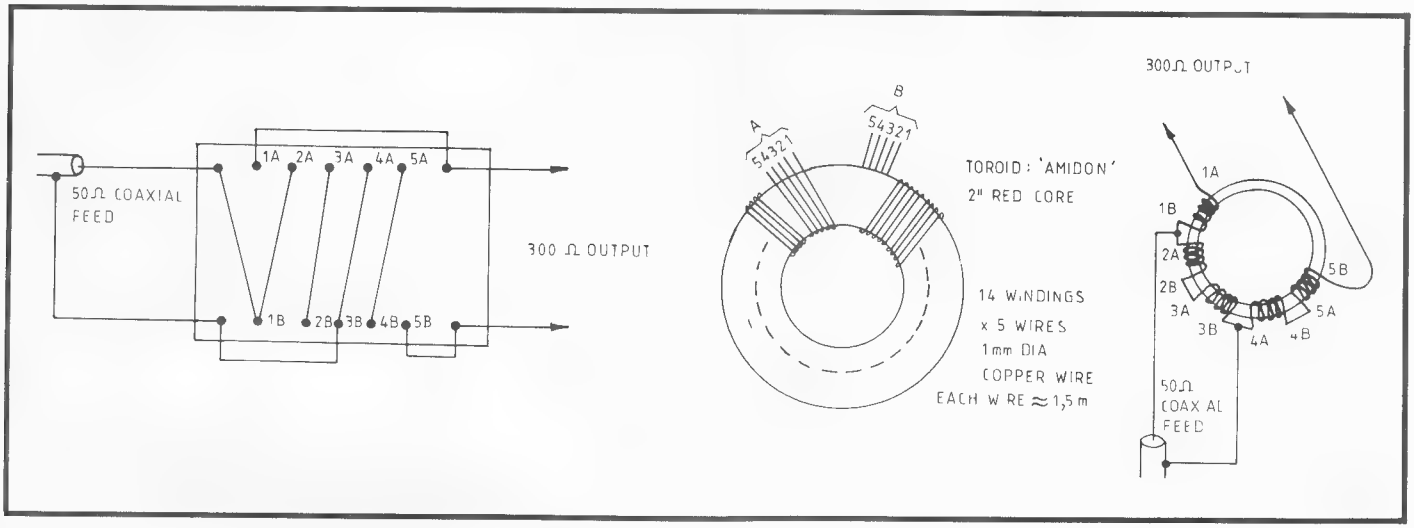
Because of past experience of ultra-violet damage to rope and plastics, some care was taken to select the appropriate materials. Black conduit was used because of its resistance to UV, and the aerial was suspended with ordinary fibre rope rather than nylon. However, it appears that fishing stores may also be a good source of ultra-violet resistant polyester or similar rope.

The performance of a typical, unadjusted aerial/transformer combination, with approximately 25m of 50 ohm coaxial feeder, is shown in the diagram. The aerial was suspended at about 40 feet.

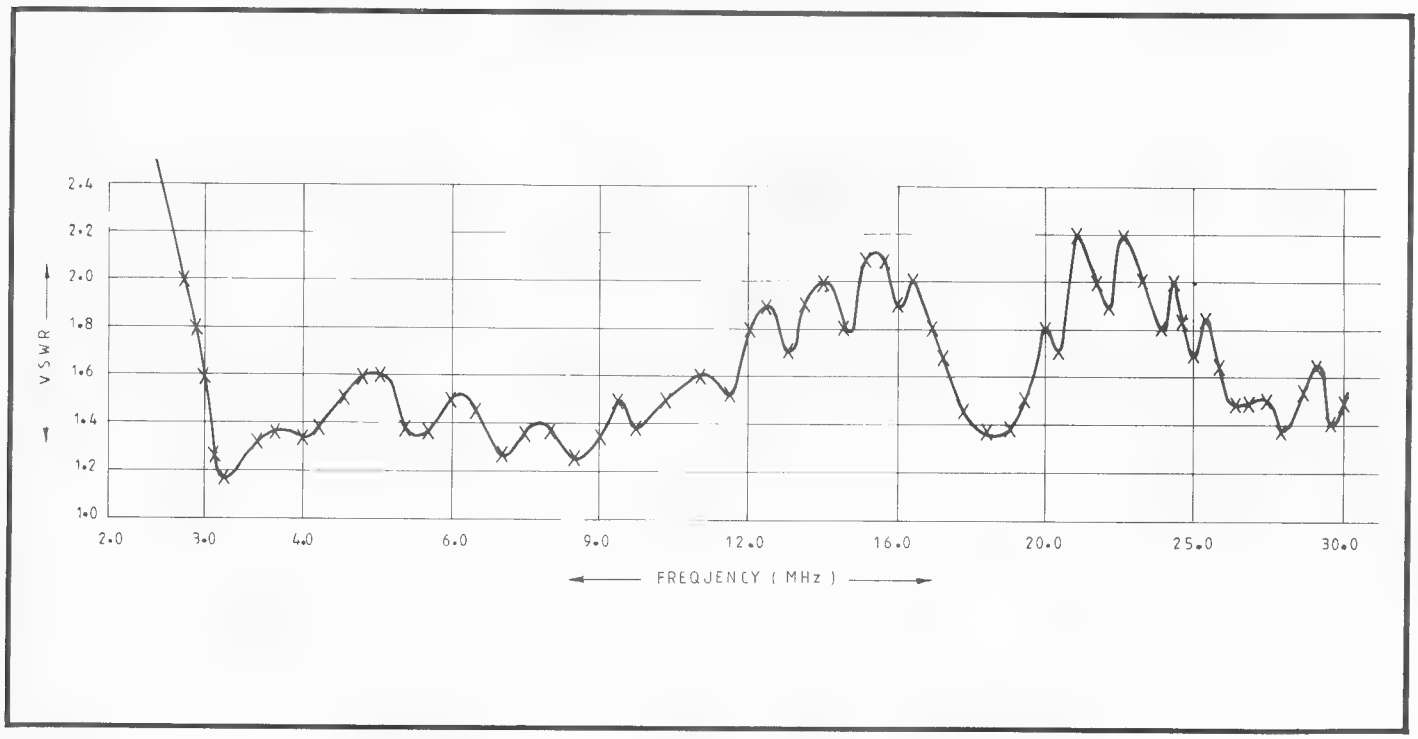
ACKNOWLEDGEMENTS AND REFERENCES

Based on a design by Dr. R. J. F. Guertler and G. E. Collyer, Antenna Engineering Australia (Pty.) Ltd.

1. "Report for the Government of the Republic of Botswana by the Consultant on Information and Broadcasting Services" — C. N. Lawrence, Commonwealth Fund for Technical Co-operation. December 1978.
2. TR-7 Service Manual; leaflet supplied with accessory filters.
3. "Amateur Radio" — Journal of the Wireless Institute of Australia, PO Box 150, Toorak, Victoria 3142, Australia. April 1974 edition.
4. ARRL Handbook.



Construction details of Transformer



Measured performance — wideband dipole VSWR against frequency